

**WARNING**

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

When you work on an electrical system, the possibility of electrical shock exists, and sparks can ignite flammable substances. You must always disconnect the battery ground cable before you work on an electrical system to prevent serious personal injury and damage to components.

## For Complete Maintenance and Diagnostics Information on the FreedomLine® Transmission

Refer to ZF Maintenance and Diagnostics Manual MM-0150, FreedomLine® Transmission, for complete maintenance and diagnostics information. To order this publication, contact the OnTrac Service Center at 866-668-7221, or visit the Tech Library at [meritorhvs.com](http://meritorhvs.com).

## Before You Make a Warranty Repair on a FreedomLine® Transmission

Call OnTrac Customer Service Center at 866-668-7221 for approval. You'll be asked to provide the transmission's model number, mileage, in-service date, serial number, VIN number and the reason for the repair.

## Fault Codes and Volt-Ohm Meter (VOM) Diagnostics

ZF FreedomLine® transmission control unit (TCU) uses a series of fault codes to identify system malfunctions that the TCU detects and stores into memory.

After you retrieve a fault code from the instrument panel display and identify the fault, use a volt-ohm meter (VOM) to test the area where the fault code indicates that the malfunction has occurred. An authorized distributor/dealer should repair the fault.

## How to Retrieve Active and Inactive Fault Codes from the Instrument Panel Display

**NOTE:** The vehicle must be stationary to retrieve active fault codes.

1. Park the vehicle and set the parking brake. Turn the engine OFF, but leave the ignition ON. Prepare to record the fault codes before you begin to retrieve them from the instrument panel display.
2. Use the following procedures to retrieve active and inactive fault codes.

## Active Fault Codes

**NOTE:** All active fault codes will steadily display for approximately 1-1/2 seconds each. **Ignore fault codes that flash.** When the TCU has listed all active fault codes, the list will repeat.

1. Press and hold the NEUTRAL button and FUNCTION button at the same time. The TCU will begin to list the active fault codes on the instrument panel display.
2. Record the fault codes.
3. When you're finished retrieving fault codes, release the NEUTRAL and FUNCTION buttons. Turn the ignition OFF.

## Inactive Fault Codes

**NOTE:** All inactive fault codes will steadily display for approximately 1-1/2 seconds each. **Ignore fault codes that flash.** When the TCU has listed all inactive fault codes, the list will repeat.

1. Press and hold the NEUTRAL button, FUNCTION button and service brake at the same time. The TCU will begin to list the inactive fault codes on the instrument panel display.
2. Record the fault codes.
3. When you're finished retrieving fault codes, release the NEUTRAL and FUNCTION buttons, and the service brake. Turn the ignition OFF.

## To View Active or Inactive Fault Codes Again

Repeat the previous steps.

## How to Clear Inactive Fault Codes from TCU Memory

**NOTE:** Inactive faults are repaired active faults that have not been cleared from TCU memory.

1. The vehicle must be stationary to clear inactive fault codes. Park the vehicle and set the parking brake. Turn the engine OFF. Turn the ignition OFF.
2. Press and hold the NEUTRAL button and the FUNCTION button at the same time.
3. Turn the ignition ON. **Do not start the engine.** Count to three and release both buttons.
4. Count to three and press and hold the NEUTRAL button and the FUNCTION button at the same time.
5. Turn the ignition OFF. Count to three and release both buttons. The fault codes will be cleared from TCU memory.



## Instrument Panel Display

Status	Display
The system is performing a self-check.	CH
The transmission is in Neutral.	N
= Automated mode (example shows 12th gear engaged)	12
= Manual mode (example shows 12th gear engaged)	12
Reverse Low is engaged.	RL
Reverse High is engaged.	RH
<b>System Malfunction</b>	<b>SM</b>
System air is low.	AL
A clutch overload occurred.	CL
Clutch wear indicator (the clutch requires replacement)	CW
NO DATA (the SAE J1587 info is absent)	--
The display line between the main transmission control unit (main TCU) and the ZF-FreedomLine transmission electronic controller (ZMTEC) is faulty.	EE
PTO 1 is activated. The transmission is in Neutral.	▲ PN
PTO 1 and 2 are activated. Third gear is engaged as a starting gear.	P3
<b>Neutral Shift Timeout</b> All truck OEMs except Freightliner LLC: The system was designed to react as follows when the vehicle idles for extended periods while in-gear: <ul style="list-style-type: none"> <li>Between 0 and 14 minutes: no outward changes</li> <li>Between 14 and 15 minutes: "NS" on the display, and you may have an audible alarm depending on vehicle configuration.</li> <li>15th minute: Transmission attempts an automated shift to neutral</li> </ul> Any changes to service brake, accelerator pedal, gearshift position, etc., reset the timer. Timer was designed to not run during PTO operation or in the event of certain critical faults.	<b>NS</b>

## System Malfunction Warning



### WARNING

If a system malfunction occurs, the instrument panel display illuminates "SM" for system malfunction, and the shift module emits a single beep. When this warning occurs, you may be unable to shift the transmission. Do not continue to operate the vehicle. Serious personal injury and damage to components can result. Safely move the vehicle to the side of the road and call for assistance.

If a system malfunction occurs, the instrument panel and shift module displays will alert you that the shift controls are not operable.

The instrument panel display illuminates **SM** for system malfunction. The shift module emits a single beep.

## What to do if a System Malfunction Occurs

1. Apply the brakes to slow the vehicle. Safely move the vehicle to the side of the road.
2. Stop the vehicle. Apply the parking brake.
3. Call for assistance.

## System Self-Check Status

"CH" will display on the instrument panel while the TCU performs a system self-check. A self-check is performed when the ignition is turned ON. Typically, the self-check continues until the engine is started, but can last longer if the TCU is being powered-up for the first time.

- **If the system self-check continues after the engine is started:** Contact the OnTrac Service Center at 866-668-7221 and request a transmission specialist.

## System Air is Low



### WARNING

If "AL" displays on the instrument panel, the transmission control unit (TCU) has determined that system air pressure is low. Apply the brakes and safely move to the shoulder of the road. Shift into neutral and idle to allow air pressure to build-up. Do not drive the vehicle with "AL" on the display. Serious personal injury and damage to components can result.

"AL" will display on the instrument panel if the TCU determines that system air pressure is low. Apply the brakes and safely move to the shoulder of the road. Shift into neutral and idle to allow air pressure to build-up. Do not drive the vehicle with "AL" on the display. Do not turn the ignition OFF with "AL" on the display. The vehicle may shut down in gear and not start until air pressure is built-up again.

## Clutch Overload Status



### WARNING

If "CL" displays on the instrument panel, the transmission control unit (TCU) has determined that the clutch is hot. Apply the brakes and safely move to the shoulder of the road. Shift into neutral and idle to allow the clutch to cool. Do not drive the vehicle with "CL" on the display. Serious personal injury and damage to components can result.

"CL" will display on the instrument panel if the TCU determines that the clutch is hot. Apply the brakes and safely move to the shoulder of the road. Shift into neutral and idle to allow the clutch to cool. Do not drive the vehicle with "CL" on the display.

## Clutch Wear Warning



### WARNING

If "CW" displays on the instrument panel, the transmission control unit (TCU) has determined that the clutch is worn. Replace the clutch. Do not drive the vehicle more than 1,000 miles (1610 km) with a worn clutch. Serious personal injury and damage to components can result.

"CW" will display on the instrument panel if the TCU determines that the clutch is worn. Replace the clutch. Do not drive the vehicle more than 1,000 miles (1610 km) with a worn clutch.





## Fault Code Diagnostics


SAE J1587 Fault Codes		Instrument Panel Display Fault Codes	Fault Description	Repair Instructions
PID/SID	Fault			
SID	20	14	Output ADVP fault (wakeup control signal for ZMTEC and voltage doubler and voltage supply to output shaft speed sensor #1)	Remove and troubleshoot the FreedomLine® vehicle wiring harness. Pin 11 of the TCU connector, pin 10 of the voltage doubler, pin 1 of the lower output shaft speed sensor (sensor #1) and pin A2 of the ZMTEC should all have continuity (resistance of 0.0 to 0.5 ohms) and not be shorted to any other circuits. If a short circuit or open circuit is found, replace the wiring harness. If not, replace the lower speed sensor (sensor #1).
PID	21	15	ECU temperature too high or ECU temperature sensor fault	Check for obstructions within the transmission cooler, cooler lines and by-pass valve. Check the oil level. Both low and high oil levels can lead to overheating. If the cooler and lines are okay, replace the TCU.
PID	31	1F	Range position sensor fault	Test drive the vehicle to verify that the transmission shifts to Neutral without request. Contact the OnTrac Service Center at 866-668-7221 with the results and request a transmission specialist.
PID	32	20	Splitter position sensor self fault	Test drive the vehicle to verify that the transmission shifts to Neutral without request. Contact the OnTrac Service Center at 866-668-7221 with the results and request a transmission specialist.
PID	33	21	Clutch actuator fault	Check the air supply for a pinched line. Check the clutch for failure to stroke. Check the release fork for failure to stroke. Verify that the release bearing is correctly engaged to the clutch.  Check the FreedomLine® transmission wiring harness for connectivity (0.0 to 0.5 ohms). Check the voltage across pins 15 and 20 of the clutch actuator assembly connector (4.75 to 5.25 VDC).
PID	34	22	Clutch actuator solenoid fault	Remove the FreedomLine® transmission wiring harness. Check for continuity (0.0 to 0.5 ohms) from pin 9 of the main TCU connector and pin E of the clutch actuator connector; pins 7 and A; pins 12 and D; and pins 8 and B. Check for shorts to the other circuits. If an issue is found with the wiring harness, replace it. If not, replace the clutch actuator assembly.
SID	35	23	High range solenoid (Y9) fault	Contact the OnTrac Service Center at 866-668-7221 and request a transmission specialist.
SID	36	24	Low range solenoid (Y8) fault	Contact the OnTrac Service Center at 866-668-7221 and request a transmission specialist.
SID	37	25	Splitter direct solenoid (Y2) fault	Contact the OnTrac Service Center at 866-668-7221 and request a transmission specialist.
SID	38	26	Splitter indirect solenoid (Y3) fault	Contact the OnTrac Service Center at 866-668-7221 and request a transmission specialist.
SID	39	27	Rail select #1 solenoid (Y4) fault	Contact the OnTrac Service Center at 866-668-7221 and request a transmission specialist.
SID	40	28	Gear engage #1 solenoid (Y6) fault	Contact the OnTrac Service Center at 866-668-7221 and request a transmission specialist.
PID	43	2B	Error on "ignition lock" signal (terminal 15)	Remove and troubleshoot the FreedomLine® vehicle wiring harness. Pin 11 of the TCU connector, pin 10 of the voltage doubler, pin 1 of the lower output shaft speed sensor (sensor #1) and pin A2 of the ZMTEC should all have continuity (resistance of 0.0 to 0.5 ohms) and not be shorted to any other circuit. If a short or open circuit is found, replace the wiring harness. If not, replace the lower speed sensor (sensor #1).
SID	48	30	Gear engage position sensor fault	Test drive the vehicle to verify that the transmission shifts to Neutral without request. Contact the OnTrac Service Center at 866-668-7221 with the results and request a transmission specialist.
SID	50	32	Rail select #2 solenoid (Y5) fault	Short circuit to ground of the output ADVP (wakeup control signal for ZMTEC and voltage doubler and voltage supply to output speed sensor #2).
SID	51	33	Gear engage #2 solenoid (Y7) fault	Contact the OnTrac Service Center at 866-668-7221 and request a transmission specialist.
SID	54	36	Inertia brake solenoid (Y1) fault	Contact the OnTrac Service Center at 866-668-7221 and request a transmission specialist.
SID	55	37	Clutch engagement/disengage fault	Check the system air pressure for 120 psi. Check the clutch actuator, release fork, push rod and clutch assembly for damage. Replace as necessary.
SID	56	38	Range shift engagement/disengage fault	Test drive the vehicle to verify that the transmission does not range shift correctly. Contact the OnTrac Service Center at 866-668-7221 with the results and request a transmission specialist.
SID	57	39	Shift lever fault or private CAN fault	Check the wiring harnesses connecting the shift lever to the transmission for open circuits and shorts.  Check the FreedomLine® vehicle transmission harness for open circuits and shorts in the private CAN circuit (pins D1 and D2 of the ZMTEC and pin 3 and 7 of the main TCU).
SID	58	3A	Main transmission engagement/disengage fault	Test drive the vehicle. Verify that the transmission does not shift correctly. Contact the OnTrac Service Center at 866-668-7221 with the results and request a transmission specialist.
SID	59	3B	Rail select cylinder engagement/disengage fault	Test drive the vehicle to verify that the transmission does not shift correctly. Contact the OnTrac Service Center at 866-668-7221 with the results and request a transmission specialist.
PID	60	3C	Rail select position sensor fault	Contact the OnTrac Service Center at 866-668-7221 and request a transmission specialist.
SID	61	3D	Splitter cylinder engagement/disengage fault	Test drive the vehicle to verify that the transmission does not shift correctly. Contact the OnTrac Service Center at 866-668-7221 with the results and request a transmission specialist.



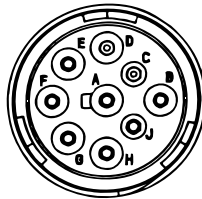
SAE J1587 Fault Codes		Instrument Panel Display Fault Codes	Fault Description	Repair Instructions
PID/SID	Fault			
SID	63	3F	Error on output shaft speed sensor #2 <b>NOTE:</b> Output shaft speed sensor #2 is a four wire harness that plugs into the transmission wiring harness (the same one that is connected to the voltage doubler and ZMTEC). It is protected with convoluted tubing. Automatic mode is available, there are no system restrictions.	<b>NOTE: The following repair instructions pertain to active faults only. For information and instructions about inactive faults, please contact the OnTrac Service Center at 866-668-7221 and request a transmission specialist.</b>  Clear the faults first and switch the OSS #1 and OSS #2 connectors. Test drive the vehicle so that an OSS code is set. If the code stays with the same speed sensor (#1 or #2), then replace the appropriate wiring harness (either the transmission wiring harness or the clutch actuator wiring harness which is integrated into the clutch actuator). If the code switches to the other speed sensor (from #1 to #2 or from #2 to #1), replace the appropriate speed sensor. If these steps don't identify the inoperative component, move on to the next set of instructions.  Remove and troubleshoot the clutch actuator wiring harness. Pin 7 of the TCU connector (J1) and pin 3 of the upper output shaft speed sensor connector (J5) (sensor #2) should have continuity (resistance of 0.0 to 0.5 ohms) and not be shorted to any other circuit. If a short or open circuit is found, replace the wiring harness. If not, replace the upper speed sensor.
PID	106	6A	Pressure reduction valve fault or pressure sensor signal fault	Contact the OnTrac Service Center at 866-668-7221 and request a transmission specialist.
SID	150	96	PTO fault	Check the wiring harness for short or open circuits. Check that the PTO pressure switch operates correctly.
SID	151	97	Plausibility error between transmission input speed and output speed. The actual speeds registered by the input shaft and output shaft speed sensors do not match the expected ratios.	Check the main TCU for programming errors. Check the FreedomLine® transmission vehicle wiring harness for short or open circuits. If there are no short or open circuits, replace both output shaft speed sensors.
SID	152	98	Main solenoid (Y1) fault	Contact the OnTrac Service Center at 866-668-7221 and request a transmission specialist.
SID	153	99	Error on ISO 14230 communications line	Remove and troubleshoot the FreedomLine® vehicle wiring harness for short circuits. Pin 2 of the TCU connector and pin F3 of the ZMTEC (sensor #2) should have continuity (resistance of 0.0 to 0.5 ohms) and not be shorted to any other circuit. If a short or open circuit is found, replace the wiring harness. If not, replace the ZMTEC.
SID	154	9A	Error on both output shaft speed sensors	Refer to each of the output shaft speed sensor repair instructions.
PID	161	A1	Input shaft speed sensor fault	Contact the OnTrac Service Center at 866-668-7221 and request a transmission specialist.
PID	177	B1	Oil temperature sensor fault	Contact the OnTrac Service Center at 866-668-7221 and request a transmission specialist.
PID	191	BF	Output shaft speed sensor #1 fault or both sources of vehicle speed are inoperative. <b>NOTE:</b> Output shaft speed sensor #1 is a three wire sensor that plugs into the clutch actuator wiring harness. It does not have convoluted tubing.	First check the SAE J1939 data link. Follow your OEM's SAE J1939 diagnostic procedures. If no data link issues are found, move on to the next set of instructions.  Clear the faults first and switch the OSS #1 and OSS #2 connectors. Test drive the vehicle so that an OSS code is set. If the code stays with the same speed sensor (#1 or #2), then replace the appropriate wiring harness (either the transmission wiring harness or the clutch actuator wiring harness which is integrated into the clutch actuator). If the code switches to the other speed sensor (from #1 to #2 or from #2 to #1), replace the appropriate speed sensor. If these steps don't identify the inoperative component, move on to the next set of instructions.  Remove and troubleshoot the clutch actuator wiring harness. Pin 11 of the driver side TCU connector (J1) and pin 4 of the lower output shaft speed sensor connector (sensor #1) should all have continuity (resistance of 0.0 to 0.5 ohms) and not be shorted to any other circuit. If a short or open circuit is found, replace the wiring harness. If not, replace the lower speed sensor.
SID	230	E6	Permanent idle signal <b>NOTE:</b> The idle switch is built into the accelerator pedal and is wired into the engine controller, not the transmission controller, or main TCU. The main TCU receives the status of the idle switch over the SAE J1939 bus. The transmission is receiving contradictory messages indicating that the idle switch is open (truck is idling) and the accelerator pedal is pressed (truck is not idling).	Troubleshoot the idle switch and the status of the pedal. Refer to the OEM for details.
SID	231	E7	SAE J1939 bus fault <b>NOTE:</b> The backbone of the SAE J1939 bus is terminated at each end with a 120 ohm resistor. Each component communicating over the bus must connect into the backbone.	Verify that the backbone of the SAE J1979 bus is correctly terminated with no short circuits or open circuits.  <b>NOTE:</b> The resistance across pins C and D of the 9 pin diagnostic connector will be about 60 ohms if both terminating resistors are in place (120 ohms if only one is installed).  Verify that the ECM and ABS controllers are correctly connected to the SAE J1939 bus and that their SAE J1939 communications are active.

SAE J1587 Fault Codes		Instrument Panel Display Fault Codes	Fault Description	Repair Instructions
PID/SID	Fault			
SID	248	F8	Output SD to display fault. The display will read "EE."	Troubleshoot the FreedomLine® vehicle wiring harness for short circuits. Pin 9 of the TCU connector and pin F2 of the ZMTEC should all have continuity (resistance of 0.0 to 0.5 ohms) and not be shorted to any other circuit. If a short or open circuit is found, replace the wiring harness, if not replace the ZMTEC.
SID	251	FB	Voltage supply fault	Check that the batteries are supplying 12 VDC to the transmission by measuring the voltage across pins G and E and across pins B and D of the OEM supplied wiring harness that connects to the FreedomLine® vehicle wiring harness.  Verify that the voltage doubler is supplying 24 VDC to the transmission by unplugging the main TCU and measuring the voltage across pins 4 and 16 and across pins 5 and 17.  Replace the voltage doubler if the truck-supplied power is acceptable, and the voltage doubler power is unacceptable.
SID	253	FD	EOL EEPROM fault	Contact the OnTrac Service Center at 866-668-7221 and request a transmission specialist.
SID	254	FE	Cut-off relay in ECU does not switch off	Contact the OnTrac Service Center at 866-668-7221 and request a transmission specialist.

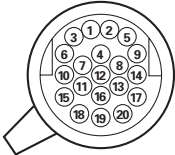

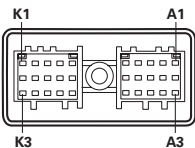
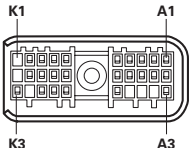
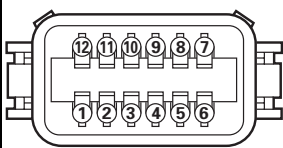
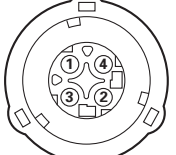
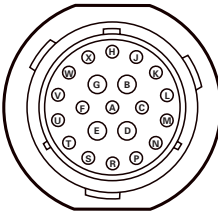
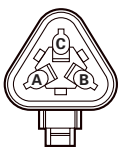
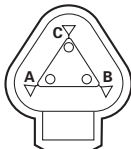

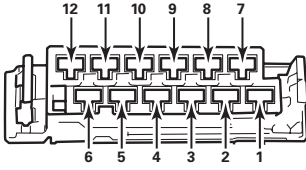

## Resistance Specifications

Component		Resistance (Measured Across Pins 1 and 2)	
Neutral Switch		In Neutral	Not in Neutral
		0.0-0.5 ohms	open circuit

## Diagnostic Connector

	Pin A	Battery (-)
	Pin B	Battery (+) Unswitched — with Unconditioned 10 A fuse
	Pin C	CAN_H Tractor Bus
	Pin D	CAN_L Tractor Bus
	Pin E	CAN_SHLD (for SAE J1939/11)
	Pin F	SAE J1708 (+)
	Pin G	SAE J1708 (-)
	Pin H	Proprietary OEM Use
	Pin J	Proprietary OEM Use

## Connector Pin Assignments

 <b>Main TCU Connector (Both Harnesses)</b>	 <b>Output Shaft Speed Sensor Connector (Both Harnesses)</b>	 <b>ZMTEC Connector (New Style)</b>	 <b>ZMTEC Connector (Old Style)</b>	 <b>Voltage Doubler Connector</b>	 <b>Neutral Switch Connector</b>
 <b>OEM Interface Connector</b>	 <b>SAE J1939 Connector</b>	 <b>Private CAN Connector</b>	 <b>PTO Connector</b>	 <b>Shifter or Turtle Wire Harness Connector</b>	 <b>2-Pin Connector (J6) J1939 Deutsch DTM Series</b>



**ZF Friedrichshafen AG**  
Commercial Vehicle and Special  
Driveline Technology  
D-88038 Friedrichshafen  
www.zf.com

# ZF-FREEDOMLINE

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